# CHEMTECH

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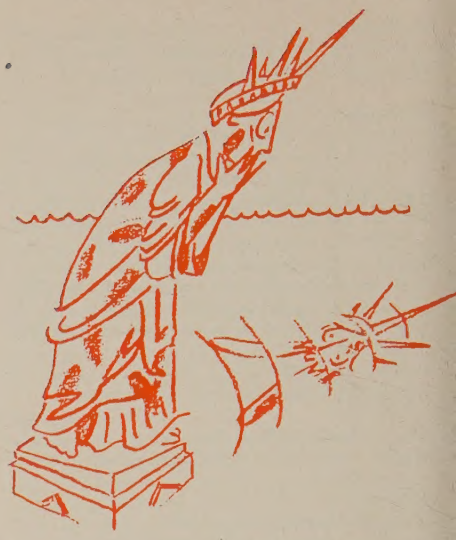


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# CHEMTECH
# AUTHOR'S GUIDE

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We would like the CHEMTECH article to have the following elements, although not all of them may be applicable to every article:

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Number literature references in order of their appearance in the text and list them in that numerical order at the end of the article. Reference numbers in text should appear in parentheses and on line, and should be italicized. They should be placed *within* punctuation, after the relevant portion of the text (in a place least disturbing to the flow of text).

Peters's review *(7)* deals with European studies; other reviews, though dated, are still useful *(8–11)*.

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(1) Hack, B. C.; Johnpeter, A. E. *Ind. Eng. Chem.* **1982**, *36*(6), 627.
(2) Greene, S. P. *The Use of Scanning Electron Microscopy*, 2nd ed.; Praeger, T., Ed.; Elsevier: New York, 1979; p. 59.
(3) Klinger, B. C. U.S. Patent 6,471,932, 1961.
(4) Bush, F. C., presented at the 22nd Congress of the International Union of Chemistry, Paris, August 1962. (*Use this style for unpublished material.*)
(5) Borscht, I. *Abstracts of Papers*, 173rd National Meeting of the Chemistry Society, Boise, MS, August 1973; Chemistry Society: Independence, MO, 1973; No. 61.

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Alan M. Schwartz

# B1NARY BØØNDØGGLE

Rick Stromoski

Even 2000 years prior to the Industrial Revolution, craftsmen knew how to evaluate the quality of their tools. A superior tool would do the job intended. A poor tool would fail at its task. As machines became larger and more complex—giant looms filling entire factories—whether they worked or not remained obvious and trivial to determine. Today, computers supervise and regulate the entirety of First World civilization. No modern computer has ever been proven to work. Theory insists such proof is impossible. Our persistent survival may be a transient wisp of illusion. Our lucky streak threatens to detonate, blasting an expansive but short path to Ragnarok.

Determining whether a complex mechanism works or does not work is straightforward, if unwieldy. Each of its many parts is run through the totality of its positions and states in relation to all the other parts evaluated in kind. If no accessible combination or permutation of conditions disables the mechanism, it works. If forbidden interminglings can be identified and locked out, what remains still works. Let us investigate the available logical states, the foundation of structure and function, of a microprocessor.

An Intel 80486 or Motorola 68040 microprocessor contains about one million, 1,000,000, e6 (a shorthand notation we will assuredly need!) transistors. There are a memory cache, a math co-processor, a RISC Integer Execution Unit, and various controllers resident on the chip surrounding and sustaining its vital heart. Each transistor may be on, or it may be off. That is simple, isn't it? The total number of logical states thereby accessible is $2^{1,000,000}$, or $10^{301,030}$. This number is written as a 1 followed by 301,030 zeros, or e301,030. This is a seriously large number.

To give e301,030 some relevant comparison: Allot the universe a generous age of 20 billion years, 20,000,000,000 years, 2e10 years. We will correct for every fourth year being a leap year with an extra day, and every century not being a leap year. The universe has thus endured a total of 6.3e26 nanoseconds. Were we to test one thousand million logical states of a microprocessor each second, the entire age of the universe would have been enough time to evaluate essentially nothing of a single device. A thousand transistors would access e301 logical states. A hundred transistors, a mere 0.01% of a modern microprocessor, are heir to e30 logical states, still a factor of more than 2000 above our time allotment. We are swimming in the deep end of a very large pool. There is no lifeguard on duty. There is no way of knowing, or even of guessing, when we may drown.

We might imagine some ill-fated hospital patient hooked, plumbed, and otherwise intimately attached to a microprocessor-controlled life support unit when the cosmic dice roll craps. Or a novelist using a word processor and offhandedly punching in the nine billionth name of God. The odds of this disaster unfolding are even longer than those of winning the California Lottery. At least the California Lottery has winners.

This "logical" peril is touchingly personal. Who can find a motor vehicle whose operation is not perniciously tied to a microprocessor's expertise? The energy flowing though copper and steel-cored aluminum conduits is regulated and apportioned by silicon and gallium arsenide logic. Telephony is no longer a manifestation of rippling physical connections, but of rivulets of solid state perambulations. The only vacuum tube in your television is probably the picture tube. Radios have not contained glass in nearly two score years. The chlorination, and even the supply, of potable water and its timely removal and treatment as sewage is the province of automation. Avalanches of foodstuffs are directed to distribution outlets, money flows though the banking system, and your existence persists in a governing bureaucracy only through microprocessor intercession. Nobody can ever know if it really works, until it doesn't.

When next you place your chance at continued survival within the tendernesses of quantum mechanics, electrical engineering, and information theory so benignly embodied within a computer's internal ruminations, reflect upon the difference between zero and infinitesimally almost but not quite zero. Ernst Mach's Principle might ring of truth. If we all stop believing, it may all go away. We are chipping, chipping, chipping away at the impossibly large e301,030. It is the Twilight of the Gods. Do you know where your ruby slippers are?

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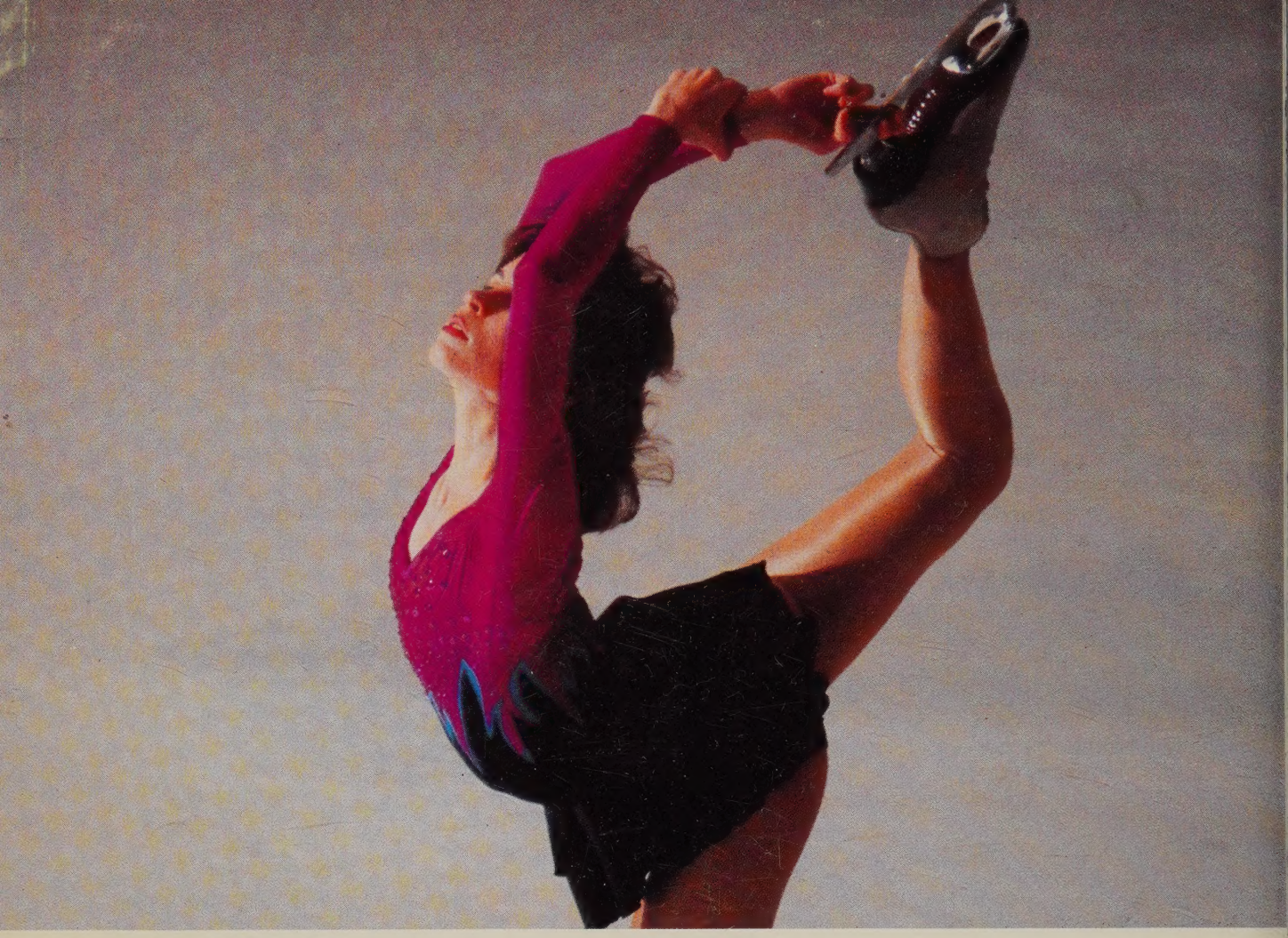

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